

Teaching Activity: Industrial CO₂ Emissions

Introduction: The dominant anthropogenic source of greenhouse gases are the industrial processes that generate CO₂ - burning of fossil fuel and the production of cement. These activities also represent the greatest opportunity for reductions of greenhouse gases to the atmosphere. Major industrial and large developing countries such as China and India rank high on the international list of the countries with the largest emissions of CO₂. On a per capita basis, however, China and India rank very low. At present, the world's total emissions are over 6.5 billion metric tons of carbon per year. The world's population is fast approaching 6 billion. Therefore, each person on the planet adds the equivalent of more than 1 metric ton of carbon to the atmosphere each year. The amount emitted varies, however, from region to region and from country to country. A concerted effort is being made on a global level to control and limit the effects of emissions as part of an international program to develop a clear and detailed picture of greenhouse gases and their sources.

Objectives:

- To calculate the per capita heating value contributed by several different countries;
- To illustrate that data in several different formats;

Important Terms: Per capita, greenhouse gases, X-axis, Y-axis, coordinates, global warming potential;

Materials: Student Activity Sheet, paper/pencil, colored pencil, ruler, calculator, graph paper;

Procedure:

1. Read and discuss the **Introduction** and the **Data Table**.
 - Be sure that students know the difference between total emissions and per capita.
 - Explain what "projected" population means.
2. Have students calculate the per capita contributions for each country using the following formula and then moving the decimal point in the final answer 3 places to the left:

$$\begin{array}{r r r r r} \text{Total carbon emissions} & - & \text{Total population} & = & \text{Per capita emissions} \\ 55,194 & \div & 28.58 & = & 1.931 \end{array}$$

- Students should record their answers on the **Data Table** in the correct spaces.

4. Students should then go on to create a bar graph of the top 15 countries with the highest total CO₂ emissions by industry sources for 1991.

- Y-axis should be labeled: **Metric tons of carbon dioxide per capita**
- X-axis should be labeled: **Country**
- Y-axis notations should proceed from: **0 at the bottom to 30 at the top;**
- A different color should be used for each country;

5. Students should write a title for their graph.

6. Students should then answer all questions in the **Analysis and Comprehension** section.

Data Table: CO₂ Emissions From Industrial Processes, 1995

Country	R A N K	Total CO ₂ (Millions of Tons)	Pop. (Project) 1995	Per Capita	COUNTRY	R A N K	Total CO ₂ (Millions of Tons)	Pop. (Project) 1995	Per Capita
Romania		138,027	23.51		United States		4,931,630	263.14	
Austria		68,331	7.86		Japan		1,091,147	125.88	
Portugal		41,792	9.88		Indonesia		170,468	201.48	
Netherlands		138,990	15.50		Sweden		53,498	8.77	
Venezuela		121,604	21.48		Nigeria		91,930	126.93	
Germany		969,630	81.26		Iraq		520,281	21.22	
Italy		402,516	57.91		Canada		410,628	28.54	
Hungary		63,574	10.47		Yugoslavia		87,225	24.11	
U.A.R.		59,459	1.79		Norway		58,672	4.36	
Iran		222,361	66.72		Switzerland		41,843	6.96	
Argentina		115,848	34.26		Poland		308,164	38.74	
China		2,543,380	1,238.32		South Africa		278,695	42.74	
Thailand		100,896	58.27		Brazil		215,601	161.38	
USSR		3,581,179	288.56		Korea, D.P.R.		243,235	23.92	
Spain		219,877	39.28		Egypt		81,667	58.52	
Czechoslovakia		191,356	15.88		Colombia		57,503	35.10	
Libya		43,008	5.41		Saudi Arabia		241,919	17.61	
India		703,550	931.04		Philippines		44,587	69.26	
France		374,113	57.77		Greece		72,866	10.25	
Belgium		102,079	10.03		Bulgaria		56,675	8.89	
Australia		261,818	18.34		Finland		52,047	5.05	
United Kingdom		577,157	58.09		Pakistan		68,487	134.97	
Mexico		339,873	93.67		Denmark		63,054	5.19	
Rep. of Korea		264,647	45.18		Algeria		55,194	28.58	
Turkey		142,555	62.03		Malaysia		61,196	20.13	

Student Activity Sheet: Industrial CO₂ Emissions

Introduction. The dominant anthropogenic source of greenhouse gases are the industrial processes that generate CO₂ - burning of fossil fuel and the production of cement. These activities also represent the greatest opportunity for reductions of greenhouse gases to the atmosphere. Major industrial and large developing countries such as China and India rank high on the international list of the countries with the largest emissions of CO₂. On a per capita basis, however, China and India rank very low. At present, the world's total emissions are over 6.5 billion metric tons of carbon per year. The world's population is fast approaching 6 billion. Therefore, each person on the planet adds the equivalent of more than 1 metric ton of carbon to the atmosphere each year. The amount emitted varies, however, from region to region and from country to country. A concerted effort is being made on a global level to control and limit the effects of emissions as part of an international program to develop a clear and detailed picture of greenhouse gases and their sources.

Objectives:

- To calculate the per capita heating value contributed by several different countries;
- To illustrate that data in several different formats;

Procedure:

1. Read and discuss the **Introduction** and **Data Table** with your teacher.
2. Calculate the per capita contributions for each country using the formula below
 - Move the decimal point in your answer 3 places to the left.

$$\begin{array}{rcccl} \text{Total carbon emissions} & \div & \text{Total population} & = & \text{Per capita emissions} \\ 55,194 & & 28.58 & = & 1.931 \end{array}$$

- Record your answers in the **Data Table**.
3. Rank each country according to its per capita contribution.
 4. Create a bar graph of the top 15 countries with the highest CO₂ emissions by industry sources for 1991.
 - Label the Y-axis: **Metric tons of carbon dioxide per capita.**
 - Label the X - axis: **Country.**
 - Make the Y-axis notations: **0 - 30 from bottom to top.**
 - Use a different color for each country.
 - Give the graph a title.
 5. Answer the questions in the **Analysis and Comprehension** section.

11. Why do you think that Iraq's contribution in 1991 was so high? _____

12. Which 3 of the top 15 countries would probably be the least comfortable to live in? Why? _____

13. What can you say about the contribution made by the U.S. as compared to the contribution made by China and India, even though all are large countries?

14. What sources of CO₂ have not been included in this data? _____

15. How would the answer in #14 affect the ranks of countries like Colombia, Brazil and Indonesia? Why? _____
